Influenza - evidence against contagion: discussion paper

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We review data relating to the epidemiology of influenza that point to the incorrectness of a simple contagion model for its propagation. The incidence rates are found to be patchy over distance scales ranging from hundreds of metres to hundreds of kilometers, strongly suggesting a connection with meteorological and atmospheric phenomena.

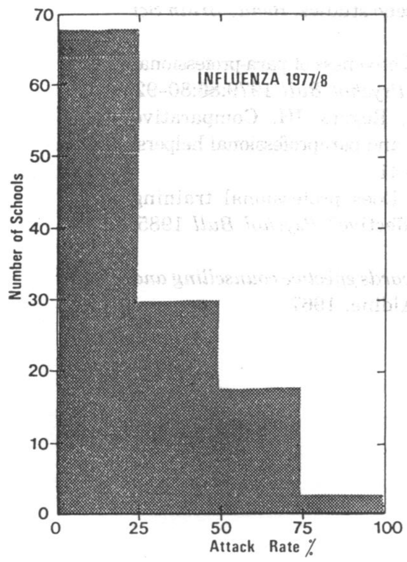

Figure 1. Histogram showing the distribution of attack rate among independent schools in England and Wales during the 1977/78 pandemic

At the end of the last century most medical practitioners took it for granted that influenza could not be fully reconciled with the idea of contagion alone. Although some physicians thought the disease might well be contagious over localized regions, person-to-person spread was considered an unlikely mechanism to operate over relatively large geographical areas. The extensive epidemiological data that was available at the time was interpreted by Charles Creighton to support his hypothesis of a 'miasma' descending over the land. Whilst such a concept was admittedly vague by its very nature, the connection with some form of meteorological phenomenon was strongly suggested by the data itself. Our own recent ideas[2,3] relating to these matters may be seen to be analogous to Creighton's point of view if the word 'miasma' were to be replaced by the phrase 'viruses from space'.

Although Creighton's conclusions were based mainly on his analysis of influenza epidemics which occurred in 1833, 1837 and 1847, this data was not significantly different from epidemiological evidence that has accumulated in subsequent years. Our own attempts to model the 1977/78 influenza epidemic in schools in England and Wales left us in little doubt as to the validity of a 'miasma-type' meteorological model. The viral particles (or particles that served as an active trigger) were required in this model[2] to be introduced at the top of the stratosphere and to be brought down worldwide to ground level by meteorological processes.

Figure 1 shows the distribution of attack rates amongst the many schools we studied showing a broad spread with a pronounced peak occurring towards the lowest attack rates. Contagion models would normally be expected to produce a histogram with the high attack rates occurring more frequently. The precise value of the attack rate in a given school in our survey was determined by its geographical location rather than by any other clearly identifiable factor. High attack rates tended to be prevalant in schools occupying open sites, while city centre schools (eg in London) tended to have low attack rates.

The convective transport of minute quantities of viral-type aerosol particles through the atmosphere would inevitably lead to a patchiness of incidence at ground level. Such patchiness would be discernible over a wide range of distance scales, from hundreds of kilometers to tens of metres. Patchiness of incidence

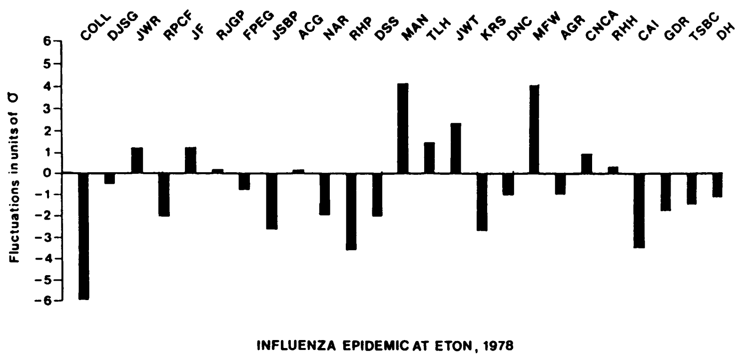

Figure 2. Deviations of case numbers of influenza above the mean expected value for the school houses at Eton College during the 1978/79 pandemic. The deviations are relative to the standard deviation computed house by house

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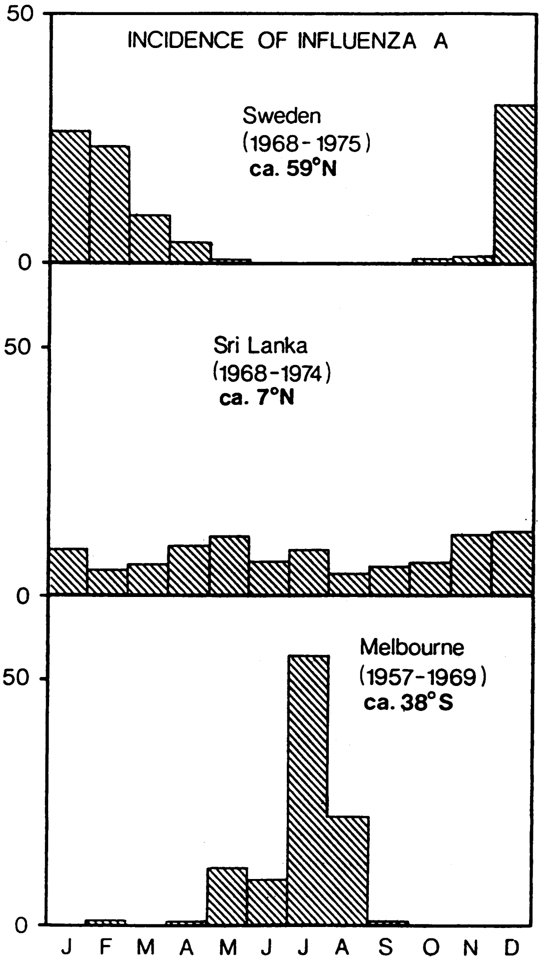

Figure 3. Incidence of influenza A in three separate countries

on a distance scale of hundreds of metres was indeed evident in the data for English and Welsh boarding schools in our 1977/78 study. This pattern is seen most clearly in the data for Eton College[2] which is displayed in Figure 2. Here a mean attack rate of 35% was distributed amongst the several school houses in such a way that some houses had case numbers representing 3 or 4 standard deviations above the mean expected value while others had case numbers implying 3-6 standard deviations below. Similar results were obtained in numerous other schools in our survey[3]. The data was clearly inconsistent with a simple case-to-case transmission model.

Some years ago Hope-Simpson and Sutherland[4] and Hope-Simpson[5] had reached an identical conclusion by studying the distribution of influenza attack rates in a household context. Hope-Simpson[5] defined a set of households by the condition that one member succumbs initially to influenza A. He then observed the subsequent fates of other members of these households to find that they had no greater chance of contracting the disease than the population at large during the epidemic. A similar survey was carried out more recently by Watkins[3] for acute upper respiratory tract disease in a set of families in a Newport, Gwent general practice leading to essentially the same result.

Hope-Simpson[5] had also noted a phase variation in the occurrence of influenza across the continent of Africa over the period 1950-51, while we ourselves[3] have assembled in Figure 3 the data issued by Public Health Authorities in Sweden, Sri Lanka and Melbourne, Australia over periods ranging from 5 years to more than a decade. A seasonal effect, presumably involving winter downdraught phenomena, is seen from Figure 3 in the data embracing the two geographical hemispheres.

We have chosen to show the data for Sweden rather than Britain, not because there is any important difference between Sweden and Britain, but to bring out the point that the simple physical cold of winter is not a relevant factor. Sweden has a very cold winter, whereas Melbourne has a clement winter not much cooler than a Swedish summer. If simple exposure to cold were important, the effect would long since have been demonstrated under controlled conditions in the laboratory which it has not. With several new subtypes arising globally in the decade under inspection, and with the frequency of air travel between Europe and Australia it is indeed surprising to find epidemics confined so sharply within seasonal limits over the two hemispheres. Transmission alone clearly cannot explain this data.

Further evidence in the same direction emerged from a study of the data for influenza in Japan which we now describe. Japan is remarkable in having high standards of medical documentation and a population density that shows an exceedingly wide contrast from cities to rural districts. Through the good offices of Professor S Yabushita we were supplied with annual influenza notification rates in each of 47 prefectures (administrative units) into which the country is

Table 1. Notifications of influenza by prefecture per 100 000

Prefecture number	*N(km^{-2})*	*1970*	*1977*	*1979*	*1980*	*1981*
8 (Ibaraki)	423	6.6	61.4	1.0	16.8	2.5
11 (Saitama)	1580	114.4	1.4	—	0.8	0.1
12 (Chiba)	869	37.4	5.5	—	6.4	4.2
13 (Tokyo)	3600	63.4	2.8	0.4	1.1	0.6
14 (Kanagawa)	2197	51.7	20.5	6.7	5.7	1.4
15 (Niigata)	205	113.3	2.0	5.4	25.2	6.3
16 (Toyama)	225	67.5	312.1	2.5	101.6	4.9
17 (Ishikawa)	217	399.7	95.9	139.1	10.8	0.4
18 (Fukui)	117	375.5	2850.4	—	57.1	264.4
19 (Yamanashi)	189	126.0	19.1	1.0	16.5	0.4
20 (Nagano)	165	5.6	49.7	5.9	3.5	—

NB, Adjacent prefecture numbers refer to physically contiguous prefectures

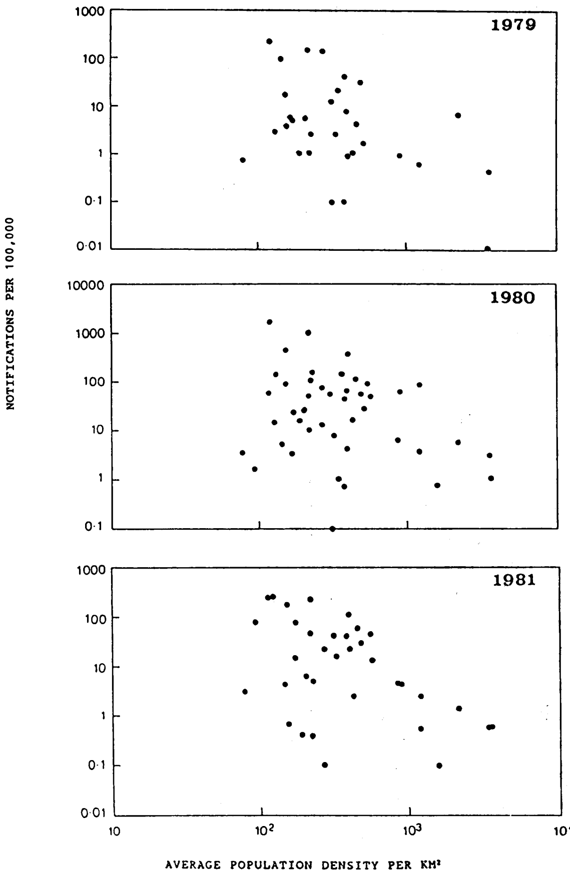

Figure 4. Influenza notification rate versus *population density by prefecture in 1979, 1980, 1981*

divided[6]. We also have estimates of the total population densities in each of these prefectures. Notification rates are only a small fraction of the total case rates, but on the average, a direct proportionality between these two indices would be expected to hold. Table 1 shows the relevant data for these prefectures over 5 years. We note that the incidence rates are exceedingly patchy from one prefecture to the next, demonstrating an 'Eton College'-type effect occurring over distance scales of ~100 km. Both high population density prefectures and low population density prefectures show precisely the same effect, an effect which again is markedly inconsistent with a contagion model.

Figure 4 shows the influenza notification rate *vs* population density in the prefectures of Japan over a period of 3 years. If the conventional contagion theory is valid to any significant degree one would expect to find a systematic increase of case rate with population density. The result seen in Figure 4 shows the reverse to be true: the attack rates, on the average, decrease with increasing population density.

An admittedly unorthodox model was proposed by us in 1977 to explain the facts relating to the epidemiology of influenza[7]. The model was connected with much wider issues concerning the origin and evolution of terrestrial life in which we argued that comets played a crucial role[8-10]. The improbability of a first origin of life on the Earth led us to consider the hypothesis of life being a cosmic rather than a purely terrestrial phenomenon. Subsequent evidence from the spectral properties of cosmic dust showed that this dust was spectroscopically indistinguishable from dessicated bacteria studied under laboratory conditions[11]. Similarly, studies of Comets Halley and Wilson had yielded data that was remarkably consistent with biological compositions for cometary dust[12-14]. The data came from in situ mass spectroscopy of Comet Halley carried out using instruments aboard the Giotto satellite, as well as from infrared spectroscopy. Figure 5 shows a comparison between the 3-4 μm infrared data for Comet Halley compared with the predictions for two models: (a) an abiotic organic model, (b) a bacterial organic model. The dashed curve on the right-hand panel includes the effect of aromatic molecules which arise as degradation products of bacteria. The bacterial models clearly show better agreement with the data than the abiotic model. The idea of comets periodically introducing biologically active particles at the top of the stratosphere would thus seem to have acquired a measure of independent empirical support.

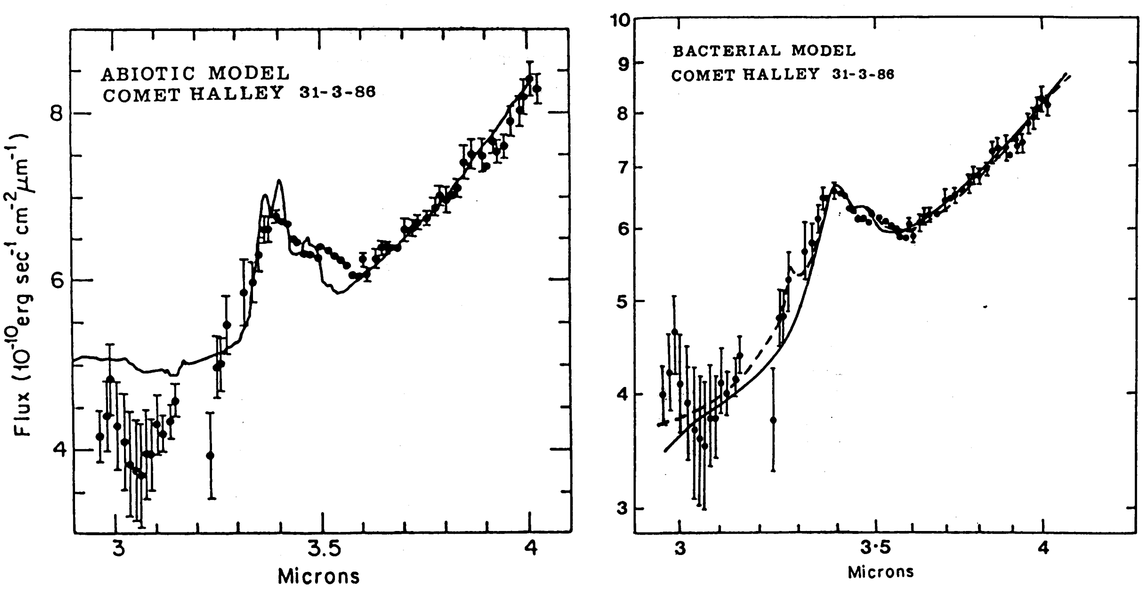

Figure 5. The curves on the right-hand panel show the calculated flux from a bacterial model, the dashed curve including the effect of aromatic molecules arising from breakdown of bacterial material; the curve on the left-hand panel is for a multi-component abiotic model proposed by Chyba and Sagan (Nature 1987;**330**:350*)*

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Forthcoming events

Home Safety Conference
25 April 1990, Churchill Threatre, Bromley High Street
This is a national conference, the main aim of which is to bring together all agencies involved with home safety and accident prevention with a view to developing model local strategies upon which Local Councils and Health Authorities can base their work. The eventual aim being to achieve a substantial reduction in accidents in the home.
Further details from: Gillian Clegg (01-313 4216) or Scott Pickering (01-313 4546)

35th General Assembly of the International Union against Venereal Diseases and the Treponematoses: Sexually Transmitted Diseases in the Age of AIDS
11 May 1990, Royal Society of Medicine, London
Further details from: Dr R D Mann, The Royal Society of Medicine, 1 Wimpole Street, London W1M 8AE

23rd Annual Advances & Controversies in Clinical Pediatrics
17-19 May 1990, San Francisco, California
Further details from: Extended Programs in Medical Education, Room C-124 University of California School of Medicine, San Francisco, CA 94143, USA (Tel: 415 476-4251)

6th Annual Current Issues Anatomic Pathology: 1990
24-25 May 1990, San Francisco, California
Further details from: (see previous entry)

World Conference on Lung Health
20-24 May 1990, Boston, Massachusetts, USA
Deadline for abstracts: 1 November 1989
Further details from: American Lung Association, 1740 Broadway, New York, NY 10019-4374, USA

Clinical Dermatology in the Year 2000
22-25 May 1990, The Barbican Centre, London
Further details from: Profesor Malcolm Greaves, Institute of Dermatology, St Thomas's Hospital, London SE1 7EH

Second Greek/Australian International Medical & Legal Conference
25 May to 1 June 1990, Rhodes, Greece
Further details from: Secretariat, ICMS, PO Box 29, Parkville, Victoria, Australia 3052

MRCP Part II Courses: Five-day Clinical
4-8 June 1990, Royal Free Hospital, London
Further details from: Dr D Geraint James, Royal Free Hospital, Pond Street, Hampstead, London NW3 2QG

7th Annual Meeting of the American Society for Bariatric Surgery
7-9 June 1990, Toronto, Ontario, Canada
Further details from: Dr D Deitel, 2238 Dundas Street West, Toronto M6R 3A9 Canada

The Threat to the Cosmic Order: Psychological, Social and Health Implications of Richard Wagner's Ring of the Nibelung
8-9 June 1990, San Francisco, California
Further details from: Extended Programs in Medical Education, Room C-124, University of California School of Medicine, San Francisco, CA 94143, USA (Tel: 415 476-4251)

Bromley Health Authority: The Family Safety Weekend
9-10 June 1990, Crystal Palace Park, London
The aim is to promote awareness of the hazards which may be encountered in the home, on the roads, at work and during leisure activities; to give information concerning ways and means of accident prevention and the correct procedures to follow in the event of an accident occurring
Further details from: Gillian Clegg (01 313-4216) or Scott Pickering (01 313-4546)

XX Congress of the International Society of Internal Medicine
17-21 June 1990, Stockholm, Sweden
Further details from: ISIM 90, Congrex, PO Box 5619. S-11486 Stockholm, Sweden, Phone +46-08 32 69 00

Advanced Training Program in Biomedical Research Management
17-28 June 1990, Elsinore, Denmark
Further details from: Professor Torben Agersnap, Institute of Organization, Copenhagen School of Economics, Blagardsgade 23 B, DK-2200 Copenhagen N, Denmark (Tel: 45 31 37 05 55)

Medical Informatics Europe 90: Health Added Value
20-23 August 1990, Scottish Exhibition and Conference Centre, Glasgow
Call for papers: deadline 1 December 1989
Further details from: Congress Secretarial, Meeting Makers. 50 Richmond Street, Glasgow G1 1XP

East-Coast Conference on Biomechanics
26-28 August 1990
Call for papers: please send one page abstract by 1 February 1990
Further details from: Professor H S Ranu, Department of Biomechanics, Nycom, New York Institute of Technology, Old Westbury, New York 11568, USA